Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings

Purpose and Intended Audience

The August 24, 2014 South Napa earthquake has reinforced past observations that wood-frame dwellings with flexible wood foundation walls (known as cripple walls) and inadequate anchorage (bolting) to the foundation are vulnerable to damage from earthquake shaking (Figure 1). Damage due to vulnerable cripple walls, particularly taller cripple walls, can be significant and costly to repair. In addition, homes with cripple wall damage are usually identified as unsafe to occupy (i.e., “red tagged”). As a result, occupants will be displaced and unable to live in their home until repairs can be performed, adding living expenses to the cost of repairing earthquake damage.

Fortunately, relatively simple and inexpensive measures can be undertaken to mitigate cripple wall vulnerabilities before an earthquake occurs. These include the installation of plywood bracing around the perimeter of the crawl space area and new anchor bolts to improve the attachment between a home and its foundation system. The FEMA Plan Set for Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings (FEMA Plan Set) accompanying this Recovery Advisory is intended to be used as a template for retrofitting common cripple wall and foundation anchorage vulnerabilities throughout California and the United States. It provides a pre-engineered retrofit solution and step-by-step instructions for use by knowledgeable contractors or skilled homeowners in customizing the work for the conditions at a specific home. **Note that building permits are always required when performing the work described in this advisory.**

This Recovery Advisory Addresses:

- Installation of pre-engineered plywood bracing and foundation anchorage details intended to improve the performance of cripple walls in wood-frame dwellings in future earthquakes.
- Information on how and when to use the FEMA Plan Set, and when to engage the services of a design professional.

This Recovery Advisory does not address the repair of cripple walls that have already been damaged in an earthquake, and does not provide a comprehensive evaluation (and retrofit) of all potential seismic vulnerabilities that can be present in a wood-frame dwelling.

Key Issues:

1. This Recovery Advisory and the FEMA Plan Set are applicable to wood-frame dwellings with a crawl space below the first floor and cripple walls up to seven feet (7’-0”) in height, among other limitations.

2. Earthquake strengthening measures illustrated in the FEMA Plan Set are intended to reduce, but not eliminate, the risk of potential damage in future earthquakes.
3. The FEMA Plan Set may not be applicable to all homes, and use of the plan set may require consultation with a licensed general contractor or design professional.

4. When the FEMA Plan Set is used, full use of all applicable details is recommended, but not required. In cases of voluntary retrofit, when existing conditions make installation of some details infeasible or too costly to perform, partial use of the plan set is encouraged to improve performance as much as practicable.

What is the FEMA Plan Set?

The FEMA Plan Set is a prescriptive, pre-engineered set of plans that can be adapted to retrofit cripple walls and foundation anchorage in wood-frame dwellings. It allows a general contractor or knowledgeable homeowner to draw the layout and specify the work required for installation of plywood bracing and additional foundation anchorage in the crawl space of a home (Figure 2). It is intended to contain all of the necessary supplemental technical information and guidance for preparation of a complete set of plans for submittal to the local building department and for use during construction.

The earthquake strengthening measures specified in the FEMA Plan Set meet the intent of the 2012 International Existing Building Code (IEBC), Chapter A3, and the 2013 California Existing Building Code (CEBC). Work is focused on the cripple walls in the crawl space area below the first floor. Wood-frame dwellings may have other vulnerable areas or other structural deficiencies that could become damaged in an earthquake. The FEMA Plan Set does not attempt to address all potential deficiencies in a home, and does not eliminate the risk of potential damage in future earthquakes.

Is the FEMA Plan Set applicable to your home?

Cripple walls can be vulnerable to earthquake damage, but not all homes with cripple walls require earthquake strengthening. Homes that are already adequately anchored to their foundation, cripple walls that are adequately braced with plywood, and homes located in regions of low seismicity (i.e., away from active earthquake faults), may not need additional work. The FEMA P-50 report, Simplified Seismic Assessment of Detached, Single-Family, Wood-Frame Dwellings (FEMA, 2012), provides a way to determine if a home needs earthquake retrofit. A design professional (such as a licensed engineer) should be consulted if there is any uncertainty in the need for strengthening.

When cripple wall strengthening is needed, the FEMA Plan Set is intended to be generally applicable in a variety of situations. However, to be eligible, a home must meet a series of requirements based on the underlying assumptions used to pre-engineer the plan set. Sheet S0 in the set lists a series of questions under the heading “Eligibility for Use.” If you can answer “yes” to all of these questions, the plan set should be generally applicable for use in your home.

Even when the FEMA Plan Set is determined to be applicable, certain conditions may require consultation with a design professional to modify the prescriptive information contained in the plan set to be fully applicable in your situation. If only isolated locations in your home deviate from the conditions shown in the plan set, a licensed engineer or architect may be able to assist on a limited basis, producing supplemental information for submittal to the building department, rather than a full project-specific set of construction documents.

How is the FEMA Plan Set used?

Adaptation of the FEMA Plan Set to your home is performed by a licensed general contractor (recommended) or by a knowledgeable homeowner. Sheets S0 through S4 of the plan set should be filled out completely,
including a scaled plan of the home and references to applicable details in Sheets D1 through D7. Sheets X1 through X4 provide examples illustrating the use of the plan set. Homeowners should consult their local building department with any questions.

The licensed contractor, or homeowner, submits the completed plan set to the local building department for a building permit. The building department may charge a fee to review the plans for conformance with local building codes. This fee may also cover site inspection services by building department representatives to ensure that the proposed work has been constructed in accordance with the building permit.

The building department may also require Special Inspection, which is on-site testing by an outside, third-party inspector that is hired by the homeowner. Although the FEMA Plan Set identifies conditions requiring Special Inspection, the local building department decides what work does and does not require Special Inspection.

Limited access and clearance in the crawl space below most homes often makes implementation of cripple wall strengthening difficult. For these reasons, it is recommended that a licensed contractor, rather than a do-it-yourself homeowner, perform the work. Since earthquake strengthening work is also specialized, homeowners should seek and engage general contractors who specialize in this type of work. Homeowners are encouraged to consult the contractor licensing board in their state for guidance on hiring a contractor to provide construction services. Many states have laws regulating the types of licenses contractors must hold, insurance requirements, bonding requirements, and liens.

**Does your home need everything in the Plan Set?**

The scope of work outlined in the FEMA Plan Set is intended to provide a reasonable level of earthquake strengthening for cripple walls and foundation anchorage. This level of strengthening is intended to reduce, but not eliminate, the risk of potential damage in future earthquakes.

Sometimes, the configuration of a home, or an obstruction in the crawl space, may make the installation of some work prescribed in the plan set infeasible, or too costly to perform. In the case of voluntary seismic improvements, partial work is often better than no work at all. Although not recommended, partial implementation of the FEMA Plan Set is encouraged to improve potential earthquake performance as much as practicable. Partial retrofit will result in a reduction in the effectiveness of the seismic strengthening work, and a correspondingly higher risk of potential damage in future earthquakes.

If a decision is made to reduce the scope of the cripple wall retrofit work, the strengthening should be implemented as symmetrically as possible around the perimeter of the crawl space. A licensed engineer or architect should be consulted if there is any uncertainty in an appropriate reduction of scope.

**Foundation Requirements**

The FEMA Plan Set applies to homes with a continuous concrete perimeter foundation system with or without reinforcement. In the preparation of this plan set, existing foundation systems consisting of stone, concrete masonry units (CMU), or brick masonry have not been addressed. Where an existing foundation system is constructed using a material other than concrete, the plan set is not applicable, and a licensed engineer or architect should be consulted. Application of the plan set also assumes the existing foundation system to be in reasonably good condition. Guidance for evaluating the quality of the existing concrete, along with additional specific requirements for the installation of tie downs or uplift anchors in existing concrete foundations, is provided as part of the plan set.

**Limitation of Liability**

Earthquake strengthening constructed in accordance with the FEMA Plan Set is intended to reduce the risk of earthquake-related damage to existing residential dwellings with wood-frame cripple walls. The content of this plan set is based on the experience and judgment of practicing engineers and limited research. All circumstances, forms, or types of construction have not necessarily been contemplated in the preparation of this plan set, and it is not possible to control the quality of construction or predict or test all conditions that may occur during an earthquake. No party associated with the preparation of this plan set makes any representation, warranty, or covenant, expressed or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of earthquake strengthening based on this plan set.
Strengthening Adjacent Garage Slabs-On-Grade

The FEMA Plan Set applies to the portions of a home with wood-frame cripple walls below the first floor. Garages, or portions of a home supported directly by concrete slabs-on-grade are not within the scope of the plan set. Although not addressed herein, such areas could also be vulnerable to earthquake damage due to inadequate connection between wood-framing and the slab-on-grade. If the presence of existing anchor bolts within accessible areas of the garage or other areas of the home cannot be verified, or if inadequate anchorage is suspected, homeowners are encouraged to consult with a licensed engineer or architect for recommendations.

Acknowledgements

This Recovery Advisory has been adapted from information originally prepared by many organizations, including the Structural Engineers Association of Northern California (SEAONC), Association of Bay Area Governments (ABAG), California Building Officials (CALBO) Emergency Preparedness Committee, Earthquake Engineering Research Institute-Northern California (EERI-NC), ICC Tri-Chapter, City of San Leandro, City of Seattle, City of Los Angeles Department of Building and Safety, and Simpson Strong-Tie. It was prepared by the Applied Technology Council (ATC) under contract with the Federal Emergency Management Agency. Work was performed by a Project Technical Committee consisting of Colin Blaney (Chair), Thor Matteson, and David L. McCormick, with the assistance of Gayle Klink and Steve R. Patton. Work was reviewed by a Project Review Panel consisting of Kelly Cobeen and Jeffrey E. Taner. Work was overseen by Michael Mahoney (FEMA Project Officer), Anna H. Olsen (ATC Project Manager), and Jon A. Heintz (ATC Program Manager).

Resources and other Useful Links


For more information, see the FEMA Building Science Earthquake Program web site at http://www.fema.gov/earthquake
If you have any additional questions on FEMA Building Science Publications, contact the helpline at FEMA-Buildingsciencehelp@fema.dhs.gov or 1-866-927-2104.

To order publications, contact the FEMA Distribution Center:
Call: 1-800-480-2520
(Monday–Friday, 8 a.m.–5 p.m., EST)
Fax: 240-699-0525
E-mail: FEMA-Publications-Warehouse@fema.dhs.gov
Additional FEMA documents can be found electronically in the FEMA Library at http://www.fema.gov/library.
HOW TO USE THIS PLAN SET

A. Before you begin:
1. Familiarize yourself with the contents of this plan set and the South Napa Earthquake Recovery Advisory FEMA DR-4193-RA2 Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings. This plan set is intended for use by a general contractor or homeowner without necessarily having to involve an engineer or architect.
2. Contact your local authority having jurisdiction (AHJ), often known as the Building Department, to understand the building permit application process. Inquire about:
   a. How many copies of the plans must be submitted
   b. How much are fees
   c. Which inspections are required
3. The AHJ may also be able to assist with assessing the applicability of this plan set to a home. See Eligibility For Use, Sheet S0.
4. Complete the Eligibility For Use questionnaire. To determine if this plan set is applicable, a "no" answer to any question disqualifies the home from using this plan set, unless a licensed engineer or architect is involved.
   a. Question 11 instructions: Visit the referenced website, enter the latitude and longitude for your property, choose 2012 BC, Site Class D, and Risk Category IV from the drop-down menus. Type address, including city and state, into search box on map.

B. Prepare your plans:
   (See Sheets X1 through X4 for definitions of terms and examples of the notation for submittal to the AHJ.)
1. Draw a scaled plan of the perimeter of the home in the graph provided on Sheet S4, Foundation and Strengthening Layout Plan. Your plan should include the following:
   a. The location of any obstructions along the perimeter of the foundation which make the strengthening work difficult or impossible such as fireplaces, water heaters, utilities, etc.
   b. An arrow to indicate the direction of the span of your floor joists plus the spacing such as "floor joists at 16" on center." This will be helpful when selecting the appropriate details shown on Sheets D1-D7.
   c. Indicate the height of the tallest cripple wall for each wall line. The minimum required length of strengthening along each wall line will be based, among other variables, on this height. See 1 on D5 for definition of "cripple wall height."
   d. Dimensions for each length of perimeter wall segment and overall dimensions of wall lines.
   e. An arrow pointing to North.
   f. Label the street side (front) of the home.

C. Gather information to complete the plans:
1. Review Technical Notes and Supplemental Technical Notes on Sheets S1 and S2 respectively for guidance on materials and installation for the required work.
2. Review the Detail Sheets included in this plan set (Sheets D1-D7). Note the details that most substantially match a home’s framing conditions. Not all details or sheets will apply. As a minimum, you should have one detail each for:
   a. Foundation sill to concrete foundation connection (Sheet D1); and
   b. Floor framing to foundation sill connection (Sheet D2); or
   c. Floor framing to cripple wall connection (Sheet D3).
3. Differences in existing conditions from those illustrated on the details that result in changes to these drawings will need to be reviewed by a licensed professional engineer or architect approved by the AHJ. See "Purpose" on Sheet S0 for additional information.
4. Using Construction Data on Sheet S3, complete section A: General Home Information. This information will be used to determine which row of information to use in the Earthquake Strengthening Schedule. Additional instructions are included on Sheet S3.
5. Check the box on the corresponding line of the Earthquake Strengthening Schedule that applies to the home. This information provides you with the length of required strengthening and number of anchors and connectors that you will need, per wall line.
6. Using the information from the Earthquake Strengthening Schedule, complete part B: Summary of Work. Additional instructions are included on Sheet S3.
7. Refer to Technical Notes, Sheet S1 for anchor and connector installation instructions. When tie-downs are required, see Supplemental Technical Notes on Sheet S2.

D. Complete your plans:
1. Using the information from the Earthquake Strengthening Schedule, add the following to complete your Foundation and Strengthening Layout Plan:
   a. Indicate and dimension the length of strengthening required at each wall line, using placement in accordance with Section E of Sheet S1 for plywood (if occurs).
   b. Identify the details used for the connections as noted above. Indicate the connection type, minimum number of connectors each wall line. Conform to Sections C and D of Sheet S1.
   c. Indicate the detail used for the plywood braced panel. (Sheets D4 or D5).
   d. Indicate the detail used for the tie-down. (Sheet D4).
   e. Indicate the detail used for the top plates splice. (Sheet D7).
   f. Indicate the details used for notching and/or outside. (Sheet D7.)

E. Submit your plans:
1. Submit a permit application and the required number of completed plan sets (Sheets S0 through D7) to the AHJ for review. Photographs of the foundation sill, cripple wall, and floor framing conditions may assist the review process.
2. Before starting work, the permit holder may be required to schedule a preconstruction inspection with the AHJ to verify that field conditions are consistent with the information provided on the approved plan.
3. Inspect(s) by the AHJ may be required for:
   a. Foundation Anchor bolts / Anchor Plate installation,
   b. Blocking,
   c. Plywood braced panel on cripple wall, sheathing and nailing,
   d. Metal hardware "connectors" installation,
   e. Tie-downs, and
   f. Final inspection.
4. Special inspection by a testing agency may be required in conjunction with Note C.1. from Table H-1 on Sheet S2.
5. No work requiring inspection shall be covered until it has been inspected and approved by the Authority Having Jurisdiction (AHJ).

Sheet List

* 00 Instructions for Use
* S0 Cover Sheet
* S1 Technical Notes
* S2 Supplemental Technical Notes
* S3 Construction Data and Earthquake Strengthening Schedule
* S4 Foundation and Strengthening Layout Plan
* D1 Foundation Sill to Concrete Foundation Connection Details
* D2 Floor Framing to Foundation Sill Connection Details
* D3 Floor Framing to Cripple Wall Connection Details
* D4 Plywood Installation at Plywood Braced Panels with Tie-Downs
* D5 Plywood Installation at Plywood Braced Panels without Tie-Downs
* D6 Foundation Replacement Details
* D7 Panel Nailing and Top Plate Details
* X1 Example - Foundation Plan
* X2 Example - Foundation Plan
* X3 Example - Cripple Wall Strengthening
* X4 Example - Strengthening - No Cripple Wall

* Sheet is for instruction and reference only.
Do not submit to the Authority Having Jurisdiction.

ACKNOWLEDGEMENTS

This Plan Set for Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings was funded by the Federal Emergency Management Agency (FEMA) as part of the South Napa Earthquake Recovery Advisory, FEMA DR-4193-RA2. This effort would not have been possible without the prior development of the following documents:

Standard Plan A (2008): Residential Seismic Strengthening Plan (produced by the Structural Engineers Association of Northern California and others); Earthquake Hazard Reduction in Existing Wood Frame Residential Buildings with Weak Cripple Walls and Unbolten Sill Plates, Standard Plan Number One (produced by the City of Los Angeles Department of Building and Safety); Seismic Retrofit for Residential Wood Frame Cripple Walls and Sill Plates Anchorages (produced by Simpson Strong-Tie); and California Building Officials (CALBO) Emergency Preparedness Committee.

In particular, the authors would like to acknowledge the organizations involved with the development of Standard Plan A (2008) including:

• The Structural Engineers Association of Northern California (SEAONC)
• The Association of Bay Area Governments (ABAG)
• California Building Officials (CALBO) Emergency Preparedness Committee
• Earthquake Engineering Research Institute, Northern California (EERI-NC)
• ICC, TRI-Chapter (East Bay, Peninsula, Monterey Bay)
• The City of San Leandro
**ELIGIBILITY FOR USE**

<table>
<thead>
<tr>
<th>To determine if a home qualifies, answer the following:</th>
<th>YES</th>
<th>NO</th>
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</thead>
<tbody>
<tr>
<td>1. Is the home a duplex or a single family residence?</td>
<td></td>
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<tr>
<td>2. Is the home two stories or less?</td>
<td></td>
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<tr>
<td>3. Are all the floors in each story at the same elevation? (Excluding slabs-on-grade)</td>
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<tr>
<td>4. Is the home constructed of wood framing?</td>
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<tr>
<td>5. Does the home have a continuous perimeter concrete foundation? (This plan set does not apply to homes supported on foundations of masonry, stone, or brick)</td>
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<tr>
<td>6. Does the home have a crawl space?</td>
<td></td>
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<tr>
<td>7. Are all the cripple walls less than seven feet in height? (See Sheet X3 for an example of how to measure a cripple wall height)</td>
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<tr>
<td>8. Is all brick or stone veneer covering exterior walls, excluding chimneys, less than four feet in height? (If the home does not have any brick or stone veneer, check &quot;YES&quot;)</td>
<td></td>
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<tr>
<td>9. Is the weight of the home's roof covering less than 11 pounds per square foot? (Shingle or metal roof coverings are often less than 11 psf; clay or concrete tile roof coverings are often more than 11 psf.)</td>
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<tr>
<td>10. Is the difference in cripple wall height between the shortest and tallest walls less than 4'-2&quot;? Note that perimeter locations with no cripple wall are to be identified as zero foot height and included in this comparison.</td>
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<tr>
<td>11. Is the site seismicity less than S = 2.34 and S = 0.97? Verify at: <a href="http://earthquake.usgs.gov/design/maps/us/application.php">http://earthquake.usgs.gov/design/maps/us/application.php</a> See Note A.4a on Sheet 00.</td>
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If you answered "YES" to each of these questions, proceed to Sheet S3.
If you answered "NO" to any of these questions, the home is not eligible to apply this plan set. See PURPOSE, Note 5.

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**PURPOSE**

1. The intent of work scope illustrated within these prescriptive drawings is to promote public safety and welfare by reducing the risk of earthquake-related damage to existing wood-frame residential dwellings with a crawl space below the bottom floor. These drawings are intended to improve the seismic performance of residential buildings but will not necessarily prevent earthquake damage, nor make a home "earthquake proof"

2. Garages or other portions of the residence built on concrete slabs on grade are not within the scope of this document. However, this plan set does apply to those portions of a dwelling that are adjacent to a portion supported on a slab-on-grade foundation but which have a raised floor framing system (crawlspace).

3. This plan set for strengthening is intended to be approved by the authority having jurisdiction (AHJ) without requiring additional plans or calculations.

4. When isolated conditions differ from those shown on the plan set, a supplemental engineered solution (including project-specific plans and calculations) shall be developed and shall be issued as an addendum to this plan set. The project-specific details and calculations must be prepared by a licensed engineer or architect.

5. Where conditions fall outside of the scope of this plan set as defined within "Eligibility for Use," or where the AHJ determines that conditions exist that are beyond the prescriptive provisions of this plan set, an alternative engineered solution (including a complete project-specific plans and calculations) shall be developed. The project-specific plan set may rely in part on this plan set, and may require design by a licensed engineer or architect as required by the AHJ.

6. Work performed under permit according to this plan set does not legalize any previous work performed without a permit.

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**LIMITATION OF LIABILITY**

Earthquake strengthening constructed in accordance with this Plan Set is intended to reduce the risk of earthquake-related damage to existing residential dwellings with wood-frame cripple walls. The content of this Plan Set is based on the experience and judgment of practicing engineers and limited research. All circumstances, forms, or types of construction have not necessarily been contemplated in the preparation of this Plan Set, and it is not possible to control the quality of construction or predict or test all conditions that may occur during an earthquake. Neither the Department of Homeland Security, the Federal Emergency Management Agency, the Applied Technology Council, nor the authors of this Plan Set makes any representation, warranty, or covenant, expressed or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of earthquake strengthening based on this Plan Set, or nor any party associated with the preparation of this Plan Set obligated or liable for actual, incidental, consequential, or other damages to users of the Plan Set, or any other person or entity arising out of or in connection with the use, condition, or performance of earthquake strengthening in accordance with this Plan Set, or the maintenance thereof.

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**ABBREVIATIONS**

- **S0** Cover Sheet
- **S1** Technical Notes
- **S2** Supplemental Technical Notes
- **S3** Construction Data and Earthquake Strengthening Schedule
- **S4** Foundation and Strengthening Layout Plan
- **D1** Foundation Sill to Concrete Foundation Connection Details
- **D2** Floor Framing to Foundation Sill Connection Details
- **D3** Floor Framing to Cripple Wall Connection Details
- **D4** Plywood Installation at Plywood Braced Panels without Tie-Downs
- **D5** Plywood Installation at Plywood Braced Panels without Tie-Downs
- **D6** Foundation Replacement Details
- **D7** Panel Notching and Top Plate Details

**FOR JURISDICTION USE**

- **AHJ** Authority Having Jurisdiction (Building Department)
- **E** Existing
- **N** New
- **min.** Minimum
- **max.** Maximum
- **NTS** Not to Scale
- **typ.** Typical

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**SHEET INDEX**

- **D1** Foundation Sill to Concrete Foundation Connection Details
- **D2** Floor Framing to Foundation Sill Connection Details
- **D3** Floor Framing to Cripple Wall Connection Details
- **D4** Plywood Installation at Plywood Braced Panels without Tie-Downs
- **D5** Plywood Installation at Plywood Braced Panels without Tie-Downs
- **D6** Foundation Replacement Details
- **D7** Panel Notching and Top Plate Details
- **S0** Cover Sheet
- **S1** Technical Notes
- **S2** Supplemental Technical Notes
- **S3** Construction Data and Earthquake Strengthening Schedule
- **S4** Foundation and Strengthening Layout Plan
- **S5** Foundation Replacement Details
- **S6** Foundation Replacement Details
- **S7** Plywood Installation at Plywood Braced Panels without Tie-Downs
- **S8** Plywood Installation at Plywood Braced Panels without Tie-Downs
- **S9** Foundation Replacement Details
- **S10** Panel Notching and Top Plate Details

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**APPLICATION INFORMATION**

- **APPLICANT:**
- **ADDRESS:**
- **PHONE:**
- **PROPERTY ADDRESS:**
- **OWNER:**
- **OWNER’S SIGNATURE:**

**INFORMATION**

- **OWNER:**
- **ADDRESS:**
- **PHONE:**

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**Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings FEMA Plan Set**

**APRIL 2015**

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**NOTES**

See PURPOSE, Note 5.
A. GENERAL

1. All existing concrete, steel anchor bolts, and wood material that will be part of the strengthening work shall be in reasonably sound condition and free from defects that would substantially reduce the capacity of the material. Any deteriorated material that is repaired or replaced shall comply with the minimum Building Code requirements for new construction. New foundations shall be as detailed on Detail 10E.

2. All metal connectors and hardware shall be installed per manufacturer’s instructions and in accordance with the requirements of this document.

3. Due to the corrosion interaction of new metallic hardware in contact with preservative treated wood, all new metal fasteners shall be hot-dipped galvanized meeting ASTM A653, and new metal connectors shall meet ASTM A 653 class G185, or better.

4. New lumber placed in contact with new or existing concrete shall be preservative-treated with Disodium Octaborate Tetrahydrate (commonly known as “DOT”) or Sodium Octa-Borate (commonly known as “SBx”), this preservative treatment does not require stainless steel connectors or fasteners. Hot-dipped galvanized connectors and fasteners are sufficient. Connectors and fasteners used for any preservative-pressure-treated lumber installed since 1990 (such as for prior repairs to termite or decay damage) shall be stainless steel. This includes all concrete anchors, washers, nails, and steel metal connectors in contact with the treated lumber. Isolation membranes are not adequate. Exception: If definitive evidence is available showing that the lumber was treated with CAI (chromated copper arsenate) or DOT/SBX, hot-dipped galvanized connectors and fasteners may be used.

5. The Owner or Contractor shall verify that existing framing conditions and those earthquake strengthening methods shown generally conform to this prescriptive plan set. Special attention should be given to any unique areas which may be present due to recent repairs for damaged conditions (rot, termite, etc.). See Note 4 for special precautions which may be required at newer preservative treated foundation sill and other floor framing.

6. The Owner or Contractor shall verify that the existing concrete within all areas to receive new anchor bolts are in reasonably good condition. Exposure of poor concrete quality would include excessive scaling, large rock pockets, cracks extending completely through the footing greater than 1/8", excessive efflorescence, or severe concrete or mortar easily scrapable with a metal knife or trowel. Strengthening should be avoided in local area of poor quality. Where these areas cannot be avoided, or where locations of poor quality are widespread, the new anchors should be tested in accordance with Table H-1, Note C.1.

7. All existing under floor ventilation shall be maintained.

B. DESIGN BASIS

1. This plan set has been developed in accordance with the 2012 International Existing Building Code (IEBC) and the California Existing Building Code (CEBC). Section A301.13 Alternate Design Procedures, assuming the following:
   a. Seismic Design Category D
   b. Site Class D
   c. Seismic Importance Factor = 1.0
   d. Spectral Acceleration in = 0.254g; Sd = 0.97g
   e. Spectral Acceleration in = 0.254g
   f. 75% factor per A901.3 of the 2012 IEBC (2013 CEBC)
   g. Response Modification Factor, R = 6.5
   h. Design Basis Shear, V = 0.135g (ASID), where V = seismic weight of building.

C. FOUNDATION CONNECTIONS

1. See Sheet D1 for required connection details.

2. New anchor bolts or connectors required by the Earthquake Strengthening Schedule (Detail 23S) shall be installed within the required length of strengthening as follows:
   a. one anchor bolt or connector at each end,
   b. space remainder of required anchor bolts or connectors as equally as possible, but not more than 32" on center nor less than 10" on center.

3. Where the required number of anchor bolts or connectors cannot be achieved within the “MINIMUM TOTAL REQUIRED LENGTH OF STRENGTHENING” as specified on Sheet 3, anchors or connectors may be placed adjacent and outside of these areas along the same wall line.

4. All foundation sill bolts shall have a 3" x 3" or 0.22" plate washer installed between the foundation sill (or blocking) and the plate. Plate washer shall be galvanized per ASTM 153.

5. New bolts shall be a minimum of 1/4" from the edges of the foundation sill or ledger, and 8" from the ends of the foundation sill or ledger.

6. Predrill sills and ledgers 1/16" larger than anchor diameter to prevent splitting. Larger holes are not permitted.

7. Existing anchor bolts may be used to satisfy minimum strengthening. The existing anchor bolts may be used to satisfy minimum strengthening as follows:
   a. one anchor bolt or connector at each end, and
   b. space remainder of required anchor bolts or connectors as nearly as possible, but not more than 32" on center nor less than 8" on center.

8. Where the required number of anchor bolts or connectors cannot be achieved within the “MINIMUM TOTAL REQUIRED LENGTH OF STRENGTHENING” as specified on Sheet 3, anchors or connectors may be placed adjacent and outside of these areas along the same wall line.

9. Threaded rod for adhesive anchors shall conform to ASTM A36 hot-dipped galvanized or stainless steel. Adhesive or screw type anchors shall be installed per manufacturer’s instructions.

10. Nails must be firmly embedded in framing behind plywood without causing splitting. Pre-drilling may be appropriate for installing nails in plywood, studs, or top and sill plates. See Sheet D5 for double stud at joint. Spread 24" on center at joint. Shear strength of connectors is based on shear strength of wood and shear strength of adhesive. Adhesive strength is based on adhesive shear strength, as shown on the drawings, sufficiently tight to prevent leakage, sufficiently strong and braced to maintain their shape and alignment until no longer needed to support the concrete.

D. FLOOR TO CRIppLE WALL or floor to fOuntATION sill CONNECTION

1. See Sheets D2 and D3 for required connection details.

2. New connectors required by the Earthquake Strengthening Schedule (Detail 23S) shall be installed within the length of required strengthening as follows:
   a. one connector at each end, and
   b. space remainder of connectors as equally as possible, but not more than 32" on center nor less than 10" on center.

3. Where the required number of connectors cannot be achieved within the “MINIMUM TOTAL REQUIRED LENGTH OF STRENGTHENING” as specified on Sheet 3, anchors of connectors may be placed adjacent and outside of these areas along the same wall line.

4. New bolts shall be a minimum of 1-3/4" from the edges of the foundation sill or ledger, and 8" from the ends of the foundation sill or ledger.

5. Increase length of nails 1/2" when attaching connectors through plywood.

6. If splices in double top plates do not have a minimum 48" nailing plate, provide a new metal strap at joint. See Detail 10D.

7. Where plate straps occur within a plywood braced panel, the strap shall be placed over the plywood and the plywood nails omitted where the strap is installed.

8. Where an existing continuous rim joist, end joist, or solid blocking between joists, does not exist above the perimeter cripple wall or foundation sill, new blocking and/or supplemental connections shall be provided per Sheet D3.

9. All blocking shall be installed with two 16d toe nails at each end of each plate.

E. PLYWOOD BRACED PANEL INSTALLATION

1. See Earthquake Strengthening Schedule (Detail 23S) for the required length of new seismic strengthening along each wall line.

2. Install plywood braced panels at each end of each wall line where possible and space additional panels, as needed, along each wall line.

3. Plywood braced panels closed to the ends of wall lines shall be located as near to the ends as practicable. Panels may be located away from the ends of a wall line when existing obstructions or limited clearance necessitate such relocations.

4. Plywood braced panels along the length of a wall line shall be nearly equal in length and shall be nearly equal in spacing where possible.

F. new FOUNdATIONS

1. REINFORCING STEEL

   b. Reinforcing steel shall conform to the following standards:
      - Deformed Bars, #3: ASTM A615, Grade 40 or Grade 60
      - Deformed Bars, #4 and larger: ASTM A615, Grade 60

   c. All bars shall have a minimum “Lap Splice” per Table F-1, unless noted otherwise.

   d. Reinforcing spacing given is maximum on-center and all reinforcing is continuous unless noted otherwise.

   e. All reinforcing steel shall be securely wired and properly supported above ground and away from the form.

   f. Do not weld reinforcing steel.

   g. Do not field bend reinforcing without equipment to ensure proper bending radii.

2. CONCRETE
   a. The minimum 28 days strength of the minimum, 2500 psi
   b. Dimensions shown for location of reinforcing are to the face of main bars, ties, etc., and denote shear (1 1/8” x 2 1/2”)
   c. Forms shall be properly constructed conforming to concrete surface as shown on the drawings, sufficiently tight to prevent leakage, sufficiently strong and braced to maintain their shape and alignment until no longer needed to support the concrete.

   d. Forms and shores shall not be removed until the concrete has attained sufficient strength to withstand all loads to be imposed without excessive stress, creep, or deflection.

   e. All items to be cast in concrete such as reinforcing, dowels, bolts, anchors, piping, sleeves, etc. shall be securely positioned in the forms before placing the concrete.

   f. Bars shall be clean of rust, grease or other materials likely to impair bond. All reinforcing bar ends shall be made cold.

Table F-1

<table>
<thead>
<tr>
<th>Reinforcement Size</th>
<th>Lap Splices</th>
</tr>
</thead>
<tbody>
<tr>
<td>#3</td>
<td>2500 psi at 28 days</td>
</tr>
</tbody>
</table>

Notes:

1. Top reinforcing is horizontal reinforcement that has more than twelve inches of concrete below it.
G. PURPOSE OF SUPPLEMENTAL TECHNICAL NOTES

1. These Supplemental Technical Notes provide guidance for the installation of plywood braced panels that employ tie-downs and existing foundation systems. They are to be used where there is insufficient length to install the specified length of plywood braced panels as specified in the Earthquake Strengthening Schedule (Detail 2/S3) and tie-downs must be used.

2. Where "With Tie-down" (as specified on the Earthquake Strengthening Schedule, Detail 2/S3) is used to determine the amount of strengthening required along each wall length, proof load testing of the installed anchor is required. Special procedures are also required for the installation of the required tie-downs and for installation of the plywood braced panels. See Section H for foundation requirements. See Sheet D4 for tie-down installation details and plywood sheathing requirements.

H. EXISTING FOUNDATION REQUIREMENTS & TESTING

1. Where tie-downs are proposed to strengthen any existing cripple walls, additional visual verification and testing of the existing foundation system is required as noted below prior to commencing any work. Tie-downs can only be used once this verification process has been completed and the size and strength of the existing foundation system has been verified. The Owner or Contractor shall complete Table H-1 which will be reviewed by the authority having jurisdiction. This may require local excavation of soil.

2. The size of existing foundation systems shall be verified to be at least 15" high ("D") and 8" wide ("W") as indicated by Detail 1D4. The use of pictures to document these conditions is encouraged.

3. The quality of the existing concrete foundation adjacent to the installation of new tie-downs shall be verified by tension tests. This verification shall be achieved by performing these tests as noted below. Torque tests as specified on Sheet D5 below, may be used to verify the anchorage capacity of existing concrete footings where required by Note A.6 on Sheet S1. Also see Note A.6 on Sheet S1 for general requirements for existing foundation systems.

a. TENSION TESTS

A minimum of one tension test shall be made along each wall line. If the test is performed on an anchor other than the tie-down, it shall not be more than 16" from the location of a proposed tie-down. These tests shall consist of installing 1/2" or 5/8" diameter threaded rods and adhesive anchors as specified by the applicable manufacturer. Minimum acceptable test values are listed in Table H-2. Tension tests shall be performed by a special inspection company hired by the owner and as approved by the AHJ.

or:

b. TORQUE TESTS

A minimum of two sacrificial torque tests shall be made along each wall line. These tests shall consist of installing 1/2" or 5/8" diameter screw-type bolts into the existing concrete and verifying that a value per Table H-2 can be achieved. Torque tests can be performed either by the owner, a general contractor, or a special inspection company hired by the owner and as approved by the AHJ.

4. The Owner (Owner performing the work) or Contractor shall complete the Table H-1 acknowledging that the existing foundation system has been visually reviewed and tested and conforms to the requirements of this section.

I. TIE-DOWN REQUIREMENTS

1. Tie-downs shall be Simpson HDU2-SDS2.5, KC Metals ADST2, USP Structural Connectors PH22A, or an equivalent able to withstand an allowable tensile load of 3075 lbs or more, installed per manufacturer's instructions.

2. End studs(s) to which tie-downs are installed, shall be 3x minimum or double 2x. For nailing at double studs, see Sheet D5.

3. All tie-downs shall use 5/8" (A36) threaded rod adhesive-type anchors with minimum embedment per Detail 1D4.

APPENDIX A: EXISTING FOUNDATION TESTING REQUIREMENTS

Table H-1: Verification of Existing Foundation System

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Yes or N/A</th>
<th>Signature of Owner or Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.1 The size of the existing foundation is greater than or equal to that specified in Section H, Item 2.</td>
<td></td>
<td>Signature</td>
</tr>
<tr>
<td>B.1 The existing foundation has generally been verified to be in good condition at locations where strengthening was done.</td>
<td></td>
<td>Signature</td>
</tr>
<tr>
<td>C.1 The capacity of the existing anchors have been verified by passing the tension tests specified in Section H, Item 3a. and:</td>
<td></td>
<td>Signature</td>
</tr>
<tr>
<td>The quality of the existing foundation is in reasonably good condition as noted in Note A.6 on Sheet S1. Where the quality of the concrete is questionable, it can be verified by passing the torque tests specified in Section H, Item 3b.or by tension test as specified in Section H, Item 3a.</td>
<td></td>
<td>Signature</td>
</tr>
</tbody>
</table>

Table H-2: Foundation Testing Requirements

<table>
<thead>
<tr>
<th>Screw Anchor</th>
<th>Adhesive Anchor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>Torque (Rt-lb)</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>50</td>
</tr>
<tr>
<td>5/8&quot;</td>
<td>80</td>
</tr>
</tbody>
</table>
**Construction Data and Earthquake Strengthening Schedule**

1. **CONSTRUCTION DATA**

   **A: GENERAL HOME INFORMATION**
   - Instructions for Section A
     - Using the home's total square footage, number of stories, and "Heavy" or "Light" construction type, mark the square footage-down to, but not less than the values listed in the Total Floor Area column of the Earthquake Strengthening Schedule.
     - 1. Square footage calculation
        - a. Number of stories above cripple wall / mud sill:
        - b. Approximate 1st floor area over crawl space:
        - (Do not include areas built over slab-on-grade.)
        - Total approximate square footage:
   - 2. Is the home "HEAVY" or "LIGHT" construction? (see below for definition)
   - Check one:
     - **HEAVY** Construction
     - **LIGHT** Construction

   **B: SUMMARY OF WORK**
   - Instructions for Section B
     - Line 1: Based on the tallest cripple wall of the entire home, write the length indicated in the "Without Tie-downs" column in the space provided. If you have a wall line not long enough to accommodate the indicated length use the "With Tie-downs" column instead. Your home may have some wall lines with and some wall lines without tie-downs.
     - Line 2: Choose and indicate the type and size of foundation sill anchors to be used. Either 1/2" or 5/8" diameter bolts may be used. Connectors type A, B, or C may be used where there is no cripple wall or the foundation sill is inaccessible.
     - Line 3: Indicate the type of connectors to be used. The connectors will be determined by your particular framing condition.
     - Line 4: Check this box if SUPPLEMENTAL TECHNICAL NOTES were used. (Required where tie-downs are used.)
     - 1. Required length of strengthening without tie-downs: \( \text{ft per wall line} \)
     - Where tie-downs are required: \( \text{ft per wall line} \)

   **DEFINITIONS - "HEAVY" OR "LIGHT" CONSTRUCTION**

   **CHECK BOX**
   - New Mudsill Anchorage used: (check all that apply)
     - Bolts: Diameter:
       - **Adhesive** Square
       - **Bolt** Square
     - Roof Framing Connectors to Mudsill or Top Plate used: (check all that apply)
       - **Type "D"**
       - **Type "E"**
       - **Type "F"**

   **CHECK BOX**
   - Check this box if SUPPLEMENTAL TECHNICAL NOTES were used. (Required where tie-downs are used.)
   - Exterior Wall Finishes: Stucco Roofing: Concrete or clay tiles weighing up to 11 pounds per square foot.

   **EARTHQUAKE STRENGTHENING SCHEDULE**

   **MINIMUM TOTAL REQUIRED LENGTH OF STRENGTHENING**
   - (at each wall line)
   - Without Tie-downs
   - With Tie-downs
   - Without Tie-downs
   - With Tie-downs
   - Without Tie-downs
   - With Tie-downs
   - Without Tie-downs
   - With Tie-downs

   **FOUNDATION SILL ANCHORAGE**
   - Technical Notes (Sheet S1), Section C
   - Min. No. of Foundation Connectors or Anchors Along Each Perimeter Wall Line

   **FLOOR TO CRIPPLE WALL**
   - Foundation Sill Anchorage Technical Notes (Sheet S1), Section D
   - Min. No. of Connectors Along Each Perimeter Wall Line

   **CONNECTORS**

   **TIE-DOWNS**
   - Supplemental Technical Notes (Sheet S2), Section L
   - Type "D" Connector
   - Type "C" Connector
   - Type "B" Connector
   - Type "A" Connector
   - Type "E" Connector
   - Type "F" Connector

   **ANCHOR BOLTS**

   **EMBEDMENT DEPTH**

   **S3**
   - APRIL 2015
   - FEMA Plan Set
   - Wood-Frame Dwellings
   - Cripple Walls in
   - S3

   **INFORMATION**

   **CONSTRUCTION DATA**

   **GENERAL INFORMATION**
   - See Note 4

   **Min. Required per wall line, placed within the length of the wall without tie downs specified in this schedule.**
   - Line 3: Indicate the type of connectors to be used. The connectors will be determined by your particular framing condition.
   - Line 4: Check this box if SUPPLEMENTAL TECHNICAL NOTES were used. (Required where tie-downs are used.)

   **A: GENERAL HOME INFORMATION**

   **1. Anchor bolts and Connectors shown in schedule are minimum required per wall line, placed within the length of strengthening where possible. Additional anchors and connectors may be necessary to meet the requirements of specific details and technical notes.**
   - **2. Tie-downs:** If your foundation meets the criteria, you may choose the tie-down option to decrease the length of strengthening. This may be required where the length of the wall without tie downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening without tie downs are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.)
   - **3. Connector Type "S" should be used as an alternate only if not bolted to both sides and where accessibility makes the use of Types "D" or "E" impractical.**
   - **4. Plywood braced panel may be omitted where cripple wall is less than 1'-0" in height. Use length of strengthening for required connectors.**

   **Notes:**

   **CONSTRUCTION DATA**

   **PROPERTY ADDRESS:**

   **Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings**

   **Cripple Walls in Wood-Frame Dwellings**

   **PLACERINE**

   **FEMA Plan Set**

   **APRIL 2015**

   **FEMA Plan Set**

   **Wood-Frame Dwellings**

   **Cripple Walls in Wood-Frame Dwellings**

   **Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings**

   **Cripple Walls in Wood-Frame Dwellings**

   **PLACERINE**

   **FEMA Plan Set**

   **APRIL 2015**

   **FEMA Plan Set**

   **Wood-Frame Dwellings**

   **Cripple Walls in Wood-Frame Dwellings**

   **Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings**

   **Cripple Walls in Wood-Frame Dwellings**

   **PLACERINE**

   **FEMA Plan Set**

   **APRIL 2015**

   **FEMA Plan Set**

   **Wood-Frame Dwellings**

   **Cripple Walls in Wood-Frame Dwellings**

   **Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings**

   **Cripple Walls in Wood-Frame Dwellings**

   **PLACERINE**

   **FEMA Plan Set**

   **APRIL 2015**

   **FEMA Plan Set**

   **Wood-Frame Dwellings**

   **Cripple Walls in Wood-Frame Dwellings**

   **Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings**

   **Cripple Walls in Wood-Frame Dwellings**

   **PLACERINE**

   **FEMA Plan Set**

   **APRIL 2015**

   **FEMA Plan Set**

   **Wood-Frame Dwellings**

   **Cripple Walls in Wood-Frame Dwellings**

   **Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings**

   **Cripple Walls in Wood-Frame Dwellings**

   **PLACERINE**

   **FEMA Plan Set**

   **APRIL 2015**

   **FEMA Plan Set**

   **Wood-Frame Dwellings**

   **Cripple Walls in Wood-Frame Dwellings**

   **Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings**

   **Cripple Walls in Wood-Frame Dwellings**
**Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings**

**FEMA Plan Set**

**Material Key**

- **Nail**
  - BL (penny): 0.131" x 2-1/2" long common
  - BR (Connectors attached over plywood): 0.131" x 1-1/2" long

- **Screws**
  - Simpson Strong-Tie #14/3" HD, 3/32" thick, or equivalent.
  - 3" long structural wood screw
  - 4" long structural wood screw
  - 6" long structural wood screw

- **Other**
  - Plywood (Plywood braced panel): 10"x12" Structural I, Exposure 1, 5-Ply.
  - NEW BLOCKING INSTALLATION LVL (Laminated Weyerhauser “Microllam”, Veneer Lumber) Boise-Cascade “VersaLam”, Georgia-Pacific “GP-Lam”
  - Edge of (E) concrete
  - Peel & Stick Flashing Tape
  - Plate Washer
  - For Connector types see Earthquake Strengthening Schedule and “Connectors” table (Detail 2/3).

**Foundation Sill to Concrete Foundation Connection Details**

**Foundation Sill Connectors**

Detail used where cripple wall studs are too short to allow drilling for new anchor bolts.

**Anchor Through Foundation Sill Only**

1. NEW BLOCKING INSTALLATION
2. ANCHOR THROUGH FOUNDATION SILL ONLY
3. ANCHOR THROUGH BLOCKING AND FOUNDATION SILL

**Foundation Sill Anchor Bolt**

Attach (N) foundation sill anchor bolt (at Connectors attached over 1-1/2" plywood) where required.

**Joint in Foundation Sill**

Attach (N) plywood braced panel where (E) foundation sill is wider than (E) cripple studs.

**Concrete Foundation**

When no plywood braced panel is required, attach (N) plywood braced panel where (E) foundation sill is 2-1/2" max. wider than (E) cripple studs.

**Concrete Foundation (shape may vary)**

At (N) plywood braced panel where (E) foundation sill is same width as (E) cripple studs.

**Foundation Sill Anchor Bolt (at Connectors attached directly to framing)**

- 0.131" x 2-1/2" long common
- 0.162" x 3-1/2" long common
- 0.195" x 4" long common

**Foundation Sill Anchor Bolt (at Connectors attached over plywood)**

- 0.131" x 1-1/2" long
- 0.148" x 2" long common
- 0.148" x 3" long common

**Foundation Sill Anchor Bolt (at Connectors attached over blocking)**

- 0.148" x 1-1/2" long

**Foundation Sill Anchor Bolt (at Connectors attached over (N) plywood braced panel)**

- 0.148" x 1-1/2" long

**Foundation Sill Anchor Bolt (at Connectors attached over (N) Plywood braced panel)**

- 0.162" x 3-1/2" long common
- 0.195" x 4" long common

**Nail**

- BL (penny): 0.131" x 2-1/2" long common
- BR (Connectors attached over plywood): 0.131" x 1-1/2" long

**Screw**

- Simpson Strong-Tie #14/3" HD, 3/32" thick, or equivalent.
- 3" long structural wood screw
- 4" long structural wood screw
- 6" long structural wood screw

**Other**

- Plywood (Plywood braced panel): 10"x12" Structural I, Exposure 1, 5-Ply.
- NEW BLOCKING INSTALLATION LVL (Laminated Weyerhauser “Microllam”, Veneer Lumber) Boise-Cascade “VersaLam”, Georgia-Pacific “GP-Lam”
- Edge of (E) concrete
- Peel & Stick Flashing Tape
- Plate Washer
- For Connector types see Earthquake Strengthening Schedule and “Connectors” table (Detail 2/3).
**FLOOR FRAMING-TO-NEW LEDGER CONNECTION**

1. INSTALL (N) 2x blocking at 4'-0" on center in the first joist space perpendicular to the (E) floor joists.
2. See table for anchor bolt size and embedment.

**FLOOR FRAMING-TO-FOUNDATION SILL CONNECTION**

1. INSTALL (N) 2x blocking at 4'-0" on center in the first joist space perpendicular to the (E) floor joists.
2. See table for anchor bolt size and embedment.

Notes:
- See Table D1 for foundation sill to concrete foundation details.
- Install (N) 2x blocking at 4'-0" on center in the first joist space perpendicular to the (E) floor joists.
- See table for anchor bolt size and embedment.

**PROPERTY ADDRESS:**

Earthquake Strengthening of Wood-Frame Dwellings

**MATERIAL KEY:**

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot; 1/2&quot;</td>
<td>1-1/2&quot; min. into (E) sill with structural screws at 6&quot; on center.</td>
</tr>
<tr>
<td>3&quot;</td>
<td>3&quot; min. to soil or use preservative treated lumber.</td>
</tr>
<tr>
<td>6&quot;</td>
<td>6&quot; min. clearance to soil or use preservative treated lumber.</td>
</tr>
<tr>
<td>(E) First floor wall framing</td>
<td>(E) First floor wall framing</td>
</tr>
<tr>
<td>(E) Rim joist or (E) blocking</td>
<td>(E) Rim joist or (E) blocking</td>
</tr>
<tr>
<td>(N) 2x blocking each bay End-nail with two 10d nails through each joint.</td>
<td>(N) 2x blocking each bay End-nail with two 10d nails through each joint.</td>
</tr>
<tr>
<td>(N) Connector Type &quot;O&quot;</td>
<td>(N) Connector Type &quot;O&quot;</td>
</tr>
<tr>
<td>(N) 3x or 4x ledger</td>
<td>(N) 3x or 4x ledger</td>
</tr>
<tr>
<td>(N) Anchor bolt and plate washer spaced at 16&quot; on center</td>
<td>(N) Anchor bolt and plate washer spaced at 16&quot; on center</td>
</tr>
<tr>
<td>(N) &quot;Peel and stick&quot; flashing to separate concrete and wood, typ.</td>
<td>(N) &quot;Peel and stick&quot; flashing to separate concrete and wood, typ.</td>
</tr>
<tr>
<td>(E) Foundation sill</td>
<td>(E) Foundation sill</td>
</tr>
<tr>
<td>(E) Floor joist</td>
<td>(E) Floor joist</td>
</tr>
<tr>
<td>(E) Concrete foundation</td>
<td>(E) Concrete foundation</td>
</tr>
<tr>
<td>(N) Connector Type &quot;B&quot; use in lieu of Detail 4/D1 where &quot;x&quot; &gt; 2-1/2&quot;</td>
<td>(N) Connector Type &quot;B&quot; use in lieu of Detail 4/D1 where &quot;x&quot; &gt; 2-1/2&quot;</td>
</tr>
<tr>
<td>1 1/2&quot; - min. into (E) sill</td>
<td>1 1/2&quot; - min. into (E) sill</td>
</tr>
<tr>
<td>See table for anchor bolt size and embedment.</td>
<td>See table for anchor bolt size and embedment.</td>
</tr>
<tr>
<td>See Table D1 for foundation sill to concrete foundation details.</td>
<td>See Table D1 for foundation sill to concrete foundation details.</td>
</tr>
<tr>
<td>Install (N) 2x blocking at 4'-0&quot; on center in the first joist space perpendicular to the (E) floor joists.</td>
<td>Install (N) 2x blocking at 4'-0&quot; on center in the first joist space perpendicular to the (E) floor joists.</td>
</tr>
<tr>
<td>See table for anchor bolt size and embedment.</td>
<td>See table for anchor bolt size and embedment.</td>
</tr>
</tbody>
</table>

**Notes:**
- See Sheet D1 for foundation sill to concrete foundation details.
- Install (N) 2x blocking at 4'-0" on center in the first joist space perpendicular to the (E) floor joists.
- See table for anchor bolt size and embedment.
Floor Framing to Cripple Wall Connection Details

1. **First Floor to Cripple Wall Connection**
   - (E) First floor wall framing
   - (E) Rim joint or (E) blocking
   - (E) Cripple stud
   - (N) 2x blocking
   - (N) or (E) 3x blocking every stud bay at (N) plywood braced panel
     If fire-blocking (draft-stop) is not present, install 4x blocking to fill stud bays
   - See Sheet D4 or D5 for installation

2. **First Floor to Cripple Wall Connection**
   - (E) First floor wall framing
   - (E) Cripple stud
   - (N) stud bay
   - Vertical and horizontal detailing as shown in Detail 4/D3

3. **First Floor to Cripple Wall Connection**
   - (E) First floor wall framing
   - (E) Floor sheathing
   - (E) or (N) Rim joint or (E) or (N) blocking
   - (E) or (N) 2x blocking or floor joist
   - (N) or (E) 3x blocking every stud bay at (N) plywood braced panel
   - See Sheet D4 or D5 for installation

4. **First Floor to Cripple Wall Connection**
   - (E) First floor wall framing
   - (E) Floor sheathing
   - (E) or (N) Rim joint or (E) or (N) blocking
   - (E) or (N) 2x blocking or floor joist
   - (N) or (E) 3x blocking every stud bay at (N) plywood braced panel
   - See Sheet D4 or D5 for installation

Note: Use detail where no joist blocks exist above cripple wall top plate

**MATERIAL KEY:***

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nails</td>
<td>8d (8 penny) 0.131&quot; x 2-1/2&quot; long common</td>
</tr>
<tr>
<td>10d (10 penny) 0.148&quot; x 2-1/2&quot; long common</td>
<td></td>
</tr>
<tr>
<td>16d (16 penny) 0.192&quot; x 4&quot; long common</td>
<td></td>
</tr>
<tr>
<td>Screws</td>
<td>Simpson Strong-Tie 1/4&quot; SDS</td>
</tr>
<tr>
<td>3/8&quot; RSS &quot;Climatek&quot;, USP Mitek 1/4&quot; WS &quot;Cold Coat&quot;, or equivalent.</td>
<td></td>
</tr>
<tr>
<td>Plywood</td>
<td>5-Ply.</td>
</tr>
<tr>
<td>Flashing Tape</td>
<td>Typar, Tyvek, Vycor, Fortiflash, Orange Peel-n-Seal, &quot;Peel &amp; Stick&quot; &quot;Flashcoat&quot;, or equivalent.</td>
</tr>
<tr>
<td>Plate Washer</td>
<td>1&quot; x 3&quot; square x 0.025&quot; thick.</td>
</tr>
<tr>
<td>For Connector types see Earthquake Strengthening Schedule and &quot;Connectors&quot; table (Detail 2/S3).</td>
<td></td>
</tr>
</tbody>
</table>

**TERM DESCRIPTION:**

- **Flash** (Flashing Tape): Non-combustible, non-flammable material used to prevent water from penetrating the wall assembly.
- **Screws**: Fasteners used to attach plywood braced panels to the framing.
- **Nails**: Fasteners used to attach plywood braced panels to the framing.
- **Braces**: Structural elements used to reinforce cripple walls.
- **Rim Joist**: The horizontal member at the foundation level that supports the floor joists.
- **Floor Joist**: The horizontal member that supports the floor sheathing.
- **Floor Sheathing**: The material used to cover and protect the floor joists.
- **Ledger**: The horizontal member that supports the sheathing and is attached to the wall framing.
- **Connector**: Fasteners used to attach plywood braced panels to the framing.
- **Drywall**: A type of wall panel used for interior walls.
- **Wood Tape**: A type of tape used to seal seams in drywall.
- **Framing Tape**: A type of tape used to seal seams in framing.
- **Type of Wood Tape**: The type of tape used to seal seams in drywall.
- **Type of Framing Tape**: The type of tape used to seal seams in framing.

**PROPERTY ADDRESS:**

**DATE:** APRIL 2015

**EARTHQUAKE STRENGTHENING OF CRIPPLE WALLS IN WOOD-FRAME DWELLINGS**

**FEMA PLAN SET**

**D3**
Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings

**TYPICAL TIE-DOWN INSTALLATION**

Plywood Installation at Plywood Braced Panels with Tie-Downs

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**Notes:**
1. For nailing at top plate splices, see Details 1D7 or 2D7.
2. At crawlspace vents or similar cripple-wall blockouts, see Detail 3D7.
3. Prior to installing plywood, see Detail 4D7 where pipes or conduits pass through cripple studs or top plates.

---

**Material Key:**

- **Nails**
  - 8d (8 penny) 0.131" x 2-1/2" long common
  - 10d (10 penny) 0.148" x 2" long common
  - 10d (10 penny) 0.148" x 3" long common
  - 16d (16 penny) 0.162" x 3-1/2" long sinkers

- **Screws**
  - Simpson Strong-Tie 1/4" SDS
  - USP Mitek 1/4" WS "Gold Coat"
  - GRK 3/8" RSS "Climatek"
  - For Connector types see Earthquake Strengthening Schedule and "Connectors" table (Detail 3/S).

- **Cement:**
  - Fortiflash, Orange Peel-n-Seal, Typar, Tyvek, Vycor, HardieWrap, or equivalent. Minimum 3" min. foundation depth "W" present. Do not drill through any (E) See Technical Notes, Sheet S2, Section H.
Plywood Installation at Plywood Braced Panels without Tie-Downs

1. **Foundation Sill Same Width as Cripple Wall**
   - Notes:
     1. For strapping at top plate splices, see Details 1/D7 or 2/D7.
     2. At crawlspace vents or similar cripple-wall blockouts, see Detail 3/D7.
     3. Prior to installing plywood, see Detail 4/D7 where pipes or conduits pass through cripple studs or top plates.

2. **Foundation Sill Wider than Cripple Wall**
   - Notes:
     1. For strapping at top plate splices, see Details 1/D7 or 2/D7.
     2. At crawlspace vents or similar cripple-wall blockouts, see Detail 3/D7.
     3. Prior to installing plywood, see Detail 4/D7 where pipes or conduits pass through cripple studs or top plates.

---

**Material Key:**
- **Nail**
  - @ (Penny): 0.131" x 2-1/2" long common
  - @ (Penny): 0.156" x 2-1/2" long common
- **Screw**
  - 2" long structural wood screw
  - 3" long structural wood screw
  - 4" long structural wood screw
  - 5" long structural wood screw

**Framing:**
- Veneer Lumber: Boise-Cascade "VersaLam", LP "Solid Start", or equivalent.
- LVL (Laminated Veneer Lumber): Weyerhaeuser "Microllam", Georgia-Pacific "GP-Lam", or equivalent.
- Plywood (Plywood braced panel): 7/32" Structural I, Exposure 1, S-Ply.
- Sheathing: Typar, Tyvek, Vycor, or equivalent.
- Flashing Tape: Fortiflash, Orange Peel-n-Seal, Peel & Stick, or equivalent.
- Plate Washer: 3" x 3" square x 0.229" thick.

**For Connector types see Earthquake Strengthening Schedule and "Connectors" table (Detail 2/S3).**
Foundation Replacement Details

CONCRETE FOUNDATION FOR SECTION REPLACEMENT

1-1/2" to 2" from center of anchor bolt
to plywood

Anchor hole diameter shall be 1/16" larger than anchor diameter

If possible, (N) sill should be same width as cripple studs

Notes:
1. Contact AHJ to verify applicability.
2. Where frost conditions occur, the minimum depth shall extend below the frost line.
3. Footing to be deepened as required to bear on firm soils.
4. When expansive soil is known to exist, the foundation depth and reinforcement shall be as approved by the AHJ.
5. The ground surface along the interior side of the foundation may be excavated to the elevation of the top of the footing.
6. Where (N) foundations are placed adjacent to (E) foundations, connect (N) and (E) foundations with three #4 x 3'-6"
dowels. Embed dowels 8" minimum into the (E) foundation with adhesive.
7. A soils report or modified foundation may be required at locations with expansive or liquefiable soils or sites with
potential for sliding.
MATERIAL KEY:

Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the present, install (N) 2x blocking with two 16d nails at each end.

- **(E)** blocking is not present; install (N) 2x blocking with two 16d nails at each end.
- **(N)** 8d at 4" on center at edges of plywood braced panel.
- **(N)** Nail stop.
- **(E)** Double cripple wall top plates.
- **(E)** Plywood braced panel, where required (Panel not shown).
- **(N)** Plywood braced panel over the top of (N) nail stops.
- **(N)** Connector Type “S1” centered at (E) upper top plate splice location. Install with fourteen 8d nails each side of the joint (twenty-eight total).
- **(E)** Single cripple wall top plate.
- **(N)** Connector Type “S2” centered at (E) upper top plate. Joint at (E) upper top plate.
- **(N)** Plywood braced panel, where required (Panel not shown).
- **(E)** Single cripple wall top plate.
- **(N)** Connector Type “S2” centered at (E) upper top plate. Joint at (E) upper top plate.
- **(N)** Plywood braced panel over the top of (N) nail stops.
- **(E)** Cripple stud.
- **(N)** Plywood braced panel, where required (Panel not shown).

**Notes:**
1. Do not cover existing vents.
2. Increase plywood braced panel length a distance equal to the length of blockout(s) or one stud bay width whichever is greater.

**CUTOUT REQUIREMENTS IN PLYWOOD BRACED PANELS**

- **(E)** Opening for vent, flood vent openings, utility blockouts, etc.
- **(N)** Opening for vent, flood vent openings, utility blockouts, etc.
- **(E)** 1-1/4" to 1-1/2" radius cut, typ.

**TOP PLATE SPlice AT EXISTING DOUBLE TOP PLates**

- **(N)** Plywood braced panel, where required (Panel not shown).
- **(E)** Cripple stud.
- **(N)** Connector Type “S1” centered at (E) upper top plate splice location. Install with fourteen 8d nails each side of the joint (twenty-eight total).
- **(E)** Cripple stud.
- **(N)** Connector Type “S2” centered at (E) upper top plate. Joint at (E) upper top plate.
- **(N)** Plywood braced panel, where required (Panel not shown).

**ALLOWABLE NOTCHING AND REINFORCING FOR TOP PLATES AND STUDS**

- **(E)** Opening for vent, flood vent openings, utility blockouts, etc.
- **(E)** 1-1/4" to 1-1/2" radius cut, typ.

**TOP PLATE SPlice AT (E) SINGLE TOP PLate**

- **(N)** Plywood braced panel, where required (Panel not shown).
- **(E)** Cripple stud.
- **(N)** Connector Type “S1” centered at (E) upper top plate splice location. Install with fourteen 8d nails each side of the joint (twenty-eight total).
- **(E)** Cripple stud.
- **(N)** Connector Type “S2” centered at (E) upper top plate. Joint at (E) upper top plate.

**Notes:**
- Floor framing not shown for clarity.

FEMA Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings Plan Set

**Property Address:**

EPA: 2015
EXAMPLE OF CALCULATING TOTAL STRENGTHENING REQUIREMENTS

Wall line = 38'-0" Max. cripple wall height: 36"

Minimum required length of strengthening = 20'-0" (Provided 5'-4" + 5'-4" + 10'-8" > 20'-0"

Example calculation. Approximate length of strengthening required for segments "a" and "b" use 16" increments:

- Wall line = 38'-0" Max. cripple wall height: 36"
- Minimum required length of strengthening = 20'-0" (Provided 5'-4" + 5'-4" + 10'-8" > 20'-0"

This sample is 1407 square foot, one-story home of "Light" construction.

Definitions:
- Plywood braced panels: New plywood installed to a length of cripple wall to provide strengthening.
- Foundation and/or cripple wall work intended to yield improved performance during an earthquake.

Wall line:
- All wall segments forming the overall building dimension on one side.

Notes:
1. Plan shows typical notation. Instructional notes are in italics and should not be included in submittal drawing. Refer to Sheet 00 for additional instructions.
2. Detail Number (Homeowner or Contractor to choose most appropriate detail)
3. Sample calculation. Approximate length of strengthening required for segments "a" and "b" use 16" increments:
   - a = 20'-0" (10'-8" + 10'-8")
   - b = 20'-0" (10'-8" + 10'-8" + 10'-8"
4. Sample calculation. Length of strengthening required for segments "c" and "d":
   - c = 20'-0" (10'-8" + 10'-8" + 10'-8"
   - d = 20'-0" (10'-8" + 10'-8"

Example - Foundation Plan

This sample is a 1407 square foot, one-story home of "Light" construction. The wall lines of this home are allowed enough length to use plywood braced panels without tie-downs. The example chooses to use 1/2" Anchor bolts for strengthening. See Note 3 for additional instructions.

- Plywood strengthening length must be at least the greater of two times the maximum cripple wall height of 24" or 4'-0" for each section along this wall line. This requirement only occurs at wall lines with tie-downs.

EXAMPLE OF NOTATION FOR SUBMITTAL TO BUILDING DEPARTMENT

This sheet is for instruction and reference only. Do not submit to the Authority Having Jurisdiction.

Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings FEMA Plan Set

APRIL 2015

FEMA
Wall line = 46'-0" Maximum cripple wall height: 6'-0"

Note: Required length values 39' rounded up to be at 1' above typical stud spacing increments.

Wall line = 46'-0" Maximum cripple wall height: 6'-0"

Typ. this wall line

Typ. this wall line

Typ. this wall line

Typ. this wall line

Indicate the direction and spacing of existing floor joists

Typical of this wall line

Indicate the height of the tallest cripple wall for the wall line.

Example of Notation for Submittal to Building Department

EXAMPLE OF NOTATION FOR SUBMITTAL TO BUILDING DEPARTMENT

Plan shows typical notation. Instructional notes are in italics and should not be included on submittal drawing.

1. Refer to Sheet 01 for additional instructions.

Example - Foundation Plan

Example of Calculating Total Strengthening Requirements

This sample is a 2392 square foot, two-story home of "Light" construction. (Excludes porch). Not all wall lines of this home allow enough length to use plywood braced panels without tie-downs, therefore plywood braced panels both with and without tie-downs will be used. The row for a 2400 square foot in the Earthquake Strengthening Schedule Sheet S3 was used to determine the needed length of 33'-4" on each wall line without tie-downs and 21'-4" for wall lines with tie-downs. This example chooses to use 5/8" Anchor Bolts, and Type "E" Connectors, to determine lengths and quantities.

Notes:
1. Plan shows typical notation. Instructional notes are in italics and should not be included on submittal drawing.
2. Detail Number (Homeowner or Contractor to choose most appropriate detail)

Key:
- Minimum required length of strengthening using plywood braced panels, anchors, and connectors
- Foundation sill anchor bolt or connector
- Floor framing connector
- Tie-down

Definitions

Plywood braced panels: New plywood installed to a length of cripple wall to provide strengthening.
Strengthening: Foundation and/or cripple wall work intended to yield improved performance during an earthquake.
Wall line: All wall segments forming the overall building dimension on one side.

This sheet is for instruction and reference only. Do not submit to the Authority Having Jurisdiction.
Example - Cripple Wall Strengthening

Notes:
1. This detail is to show an example of cripple wall that has gone through an earthquake retrofit and to identify terms and details used in this plan set.
2. This detail is not intended to supersede requirements contained in the specific installation details on Sheets D1 through D7.
3. This view is looking from the interior of the crawl space.

Definitions
- Plywood braced panels: New plywood installed to a length of cripple wall to provide strengthening.
- Strengthening: Foundation and/or cripple wall work intended to yield improved performance during an earthquake.
- Wall line: All wall segments forming the overall building dimension on one side.

Notes:
1. This detail is to show an example of cripple wall that has gone through an earthquake retrofit and to identify terms and details used in this plan set.
2. This detail is not intended to supersede requirements contained in the specific installation details on Sheets D1 through D7.
3. This view is looking from the interior of the crawl space.

Definitions
- Plywood braced panels: New plywood installed to a length of cripple wall to provide strengthening.
- Strengthening: Foundation and/or cripple wall work intended to yield improved performance during an earthquake.
- Wall line: All wall segments forming the overall building dimension on one side.
Notes:
1. This detail is to show an example of an earthquake retrofit where there is no cripple wall, and to identify terms and details used in this plan set.
2. This detail is not intended to supersede requirements contained in the specific installation details on Sheets D1 through D7.
3. This view is looking from the interior of the crawl space.

Example - Strengthening - No Cripple Wall